

REMARKS/ARGUMENTS

Summary

In this Office Action, claims 1-5 and 8 stand rejected under 35 U.S.C. §103(a) as being unpatentable over U.S. Patent 6,476,498 issued to Marathe (hereinafter "*Marathe*") in view of U.S. Patent 5,592,024 issued to Aoyama et al. (hereinafter "*Aoyama*") or U.S. Patent 6,806,184 issued to Chen et al. (hereinafter "*Chen*"). Additionally, claims 5-8 stand rejected under 35 U.S.C. §103(a) as being unpatentable over *Marathe* taken with *Aoyama* or *Chen*, and further in view of U.S. Patent Application Publication 2002/0024150 of Farrar (hereinafter "*Farrar*"). Further, claims 21-24 stand rejected under 35 U.S.C. §103(a) as being unpatentable over *Marathe* taken with *Aoyama* or *Chen*, and further in view of *Farrar* and U.S. Patent Application Publication 2002/0184490 of McCown et al. (hereinafter "*McCown*").

Thus, claims 1-8 and 21-24 currently are pending.

Claim Rejections under 35 U.S.C. § 103(a)

1. Claims 1-5 and 8: *Marathe/Aoyama* or *Chen*

Claims 1-5 and 8 stand rejected under 35 U.S.C. §103(a) as being unpatentable over *Marathe* in view of *Aoyama* or *Chen*. Applicants respectfully traverse the rejections because, at a minimum, *Marathe* does not teach or suggest the invention as claimed, and further, because there is no suggestion in *Marathe*, *Aoyama*, or *Chen* to combine their respective teachings to arrive at the claimed invention. Indeed, *Marathe* expressly teaches away from the claimed invention. Therefore, Applicants believe that independent claim 1 is allowable, and thus claims 2-5 and 8 which depend from claim 1, must also be allowable.

It is well settled that in obviousness rejection, there must be some suggestion or teaching to combine the prior art references. Such suggestion or teaching is not present if one of the references teaches away from combination, i.e., if a person of ordinary skill in the art "would be led in a direction divergent from the path that was

taken by the applicant.” *Tec Air, Inc. v. Denso Mfg. Mich., Inc.*, 192 F.3d 1353, 1360 (Fed. Cir. 1999).

Independent claim 1 is directed to a semiconductor device comprising:

- a substrate;
- a dielectric layer formed over the substrate;
- a damascene interconnect structure defined in the dielectric layer, the damascene interconnect structure having a bottom portion not coupled to a conductive channel; and
- a barrier layer deposited over the dielectric layer and within the damascene interconnect structure, the barrier layer within the damascene interconnect structure being tapered.

Thus, the invention as claimed discloses a semiconductor device comprising a damascene structure not coupled to a conductive channel and a barrier layer within the damascene structure being tapered. When viewed in whole, the invention as claimed discloses a novel structural combination improving gap fill.

In contrast, *Marathe* discloses an integrated circuit having a first conductive channel **202** and an opening comprising a via opening **206** and a conductive channel opening **202**, the structure further having a thicker barrier layer **232** on the bottom of the via opening **206** to prevent void nucleation near the via/second conductive channel interface **238**. See *Marathe*, Figure 3. The Examiner suggested in this Office Action that *Marathe*’s via opening 206 has a tapered barrier layer **232**. Even if that were indeed the case, which Applicants contend it is not, *Marathe*’s structure cannot be said to disclose or suggest a damascene structure having a bottom portion not coupled to a conductive channel. Rather, *Marathe* discloses a damascene structure having a bottom portion coupled to a conductive channel and a thicker barrier layer on the bottom, the coupling and thicker barrier layer preventing void nucleation near the via/conductive channel interface. See *Marathe*, column 1, lines 7-8; column 3, lines 17-29; column 3, lines 39-44, 50-55; column 4, lines 55-56; column 5, lines 52-56; claims 1 and 6 (“barrier layer thicker in the via opening than in the channel opening wherein current crowding

will be reduced and Joule heating will be reduced"). Therefore, *Marathe* fails to disclose each and every element of the claimed invention.

Examiner also asserted that although *Marathe* fails to disclose all elements of the claimed invention, it would have been obvious to modify *Marathe* in view of *Aoyama* or *Chen* to form damascene structures having bottom portions not coupled to a conductive channel. However, Applicants respectfully disagree and assert that *Marathe* actually teaches away from the modification the Examiner suggested. *Marathe* discloses the elimination of void nucleation at via/conductive channel interfaces by enlisting a thicker barrier layer at those interfaces. See *Marathe*, column 3, lines 39-44, 50-55; column 5, lines 52-56; claims 1 and 6 ("barrier layer thicker in the via opening than in the channel opening wherein current crowding will be reduced and Joule heating will be reduced"). Indeed, *Marathe*'s entire disclosure is directed solely to those types of interfaces. Still further, this limitation is made clear by reference to *Marathe*'s drawing which shows a thicker barrier layer only at those interfaces, all other barrier layers being thin and untapered. See *Marathe*, Figure 3. *Marathe* expressly discloses that "the barrier **232** is optimized by increasing the thickness of the bottom **231** over the first channel **202** and the thickness of the sides **233** on the sidewalls of the via dielectric **212** over the thickness outside of the via **206**." Thus, it is indisputable that *Marathe* expressly mandates that the thickness of the barrier layer at the via/conductive channel interface is greater than the thickness of the barrier layer elsewhere. Thus, *Marathe* clearly and expressly teaches away from using a thicker (or tapered, as the Examiner contended) barrier layer within a damascene structure having a bottom portion not coupled to a conductive layer. As *Marathe* expressly teaches away from combining with references such as *Aoyama* or *Chen* to form a thicker barrier layer for damascene structures having bottom portions not coupled to a conductive channel, the cited prior art references do not alone or in combination teach or suggest every element of the claimed invention.

As *Marathe* expressly teaches away from combining with either of the cited prior art references, the claimed invention cannot be said to be obvious in light of *Marathe*

alone or in combination with *Aoyama* or *Chen*. Therefore, for at least the foregoing reasons, independent claim 1 is patentable over said references. Further, dependent claims 2-5 and 8 depend from claim 1 and therefore also are patentable over *Marathe*.

2. Claims 5-8: *Marathe/Aoyama* or *Chen/Farrar*

Claims 5-8 stand rejected under 35 U.S.C. §103(a) as being unpatentable over *Marathe* taken with *Aoyama* or *Chen*, and further in view of *Farrar*. Applicants respectfully traverse. *Farrar* does not remedy the above-discussed deficiencies of *Marathe* and thus, for at least the same reasons, claim 1 remains patentable over *Marathe*, *Aoyama*, and *Chen* even when combined with *Farrar*. Claims 5-8 depend from claim 1 thereby incorporating the limitations of claim 1. Therefore, claims 5-8 are patentable over *Marathe*, *Aoyama*, *Chen*, and *Farrar* combined and are in proper form for allowance.

3. Claims 21-24: *Marathe/Aoyama* or *Chen/Farrar/McCown*

Claims 21-24 stand rejected under 35 U.S.C. §103(a) as being unpatentable over *Marathe* taken with *Aoyama* or *Chen*, and further in view of *Farrar* and *McCown*. Applicants respectfully traverse. Independent claim 21 includes the same limitations as those of claim 1 and thus, for at least the same reasons discussed above, Applicants respectfully submit that claim 21 also is patentable over *Marathe*, *Aoyama*, *Chen*, and *Farrar*. *McCown* does not remedy the above-discussed deficiencies of those references and thus, for at least the same reasons, claim 21 is patentable over those references, even when combined with *McCown*. Claims 22-24 depend from claim 21 thereby incorporating the limitations of claim 21. Therefore, claims 21-24 are patentable over *Marathe*, *Aoyama*, *Chen*, *Farrar*, and *McCown* combined and are in proper form for allowance.

CONCLUSION


In view of the foregoing, Applicants respectfully submit that claims 1-8 and 21-24 are in condition of allowance. Thus, entry of the offered amendments and early issuance of Notice of Allowance is respectfully requested.

The Commissioner is hereby authorized to charge shortages or credit overpayments to Deposit Account No. 500393.

Respectfully submitted,

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